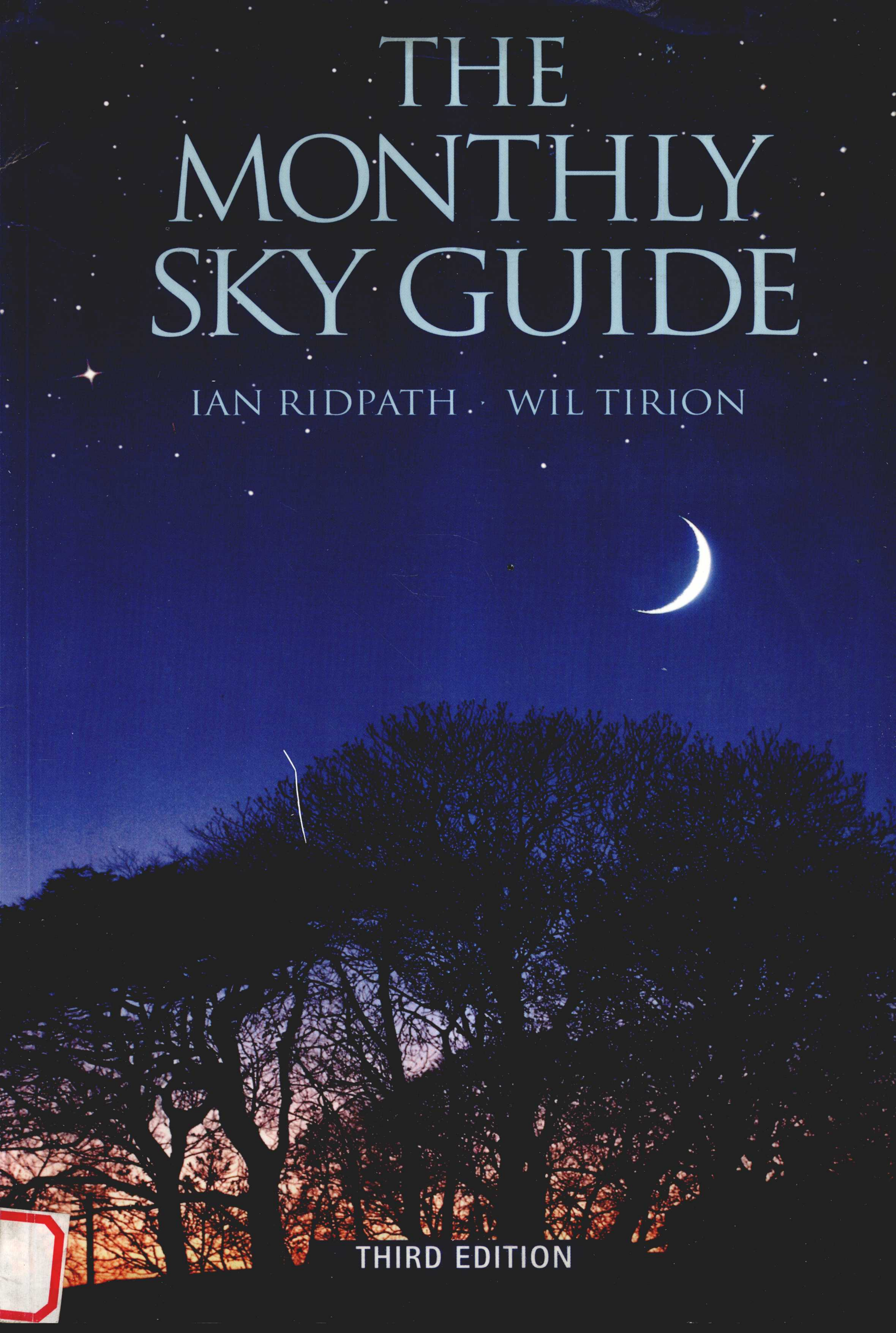
THE MONTHLY SKY GUIDE

IAN RIDPATH · WIL TIRION



THIRD EDITION

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For not in vain we watch the constellations,
Their risings and their settings, not in vain
The fourfold seasons of the balanced year.

Teach me to know the paths of the stars in heaven,
The eclipses of the Sun and the Moon's travails

From The Georgics by Virgil.
translated into English verse
with an introduction and notes
by L.P. Wilkinson (Penguin Classics, 1982),

INTRODUCTION

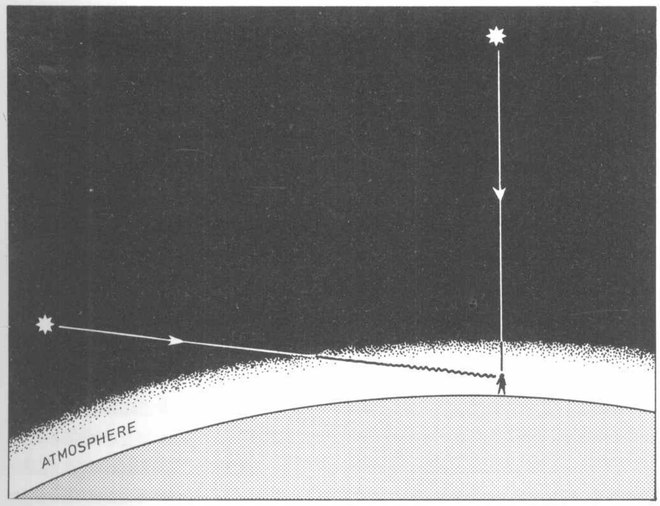
Stars are scattered across the night sky like sequins on velvet. Over 2000 of them are visible to the unaided eye at any one time under the clearest conditions, but most are faint and insignificant. Only a few hundred stars are bright enough to be prominent to the naked eye, and these are plotted on the monthly sky maps in this book. The brightest stars of all act as signposts to the rest of the sky, as shown on pages 14–15. It is a welcome fact that you need to know only a few dozen stars to find your way around the sky with confidence. This book will introduce you to the stars month by month, without the need for optical aid, so that you become familiar with the sky throughout the year.

What is a star?

All stars are suns, blazing balls of gas like our own Sun, but so far away that they appear as mere points of light in even the most powerful telescopes. At the centre of each star is an immense natural nuclear reactor, which produces the energy that makes the star shine. Stars can shine uninterrupted for billions of years before they finally fade away.

Many stars have noticeable colours – for example, Antares, Betelgeuse and Aldebaran are reddish-orange. The colour of a star tells us its temperature. Orange and red stars have surfaces that are not as hot as that of the Sun, which is yellow-white. The hottest stars of all appear blue-white, notably Rigel, Spica and Vega. Star colours are more distinct when viewed through binoculars or telescopes.

The familiar twinkling of stars is nothing to do with the stars themselves. It is caused by currents of air in the Earth's atmosphere, which produce an effect similar to a heat haze. Stars close to the horizon twinkle the most because we see them through the thickest layer of atmosphere (see diagram). Bright stars often flash colourfully from red to blue as they twinkle; these colours are due to the star's light being broken up by the atmosphere.



Stars near the horizon seem to twinkle, because their light passes through more of the Earth's atmosphere than light from stars overhead.

What is a planet?

Nine planets, including the Earth, orbit the Sun. The basic difference between a star and a planet is that stars give out their own light but planets do not. Planets shine in the sky because they reflect the light of the Sun. They can consist mostly of rock, like our Earth, or they can be composed of gas, as are Jupiter and Saturn.

Planets are always on the move, so they cannot be shown on the maps in this book. The three outermost planets – Uranus, Neptune and Pluto – are too faint to be seen with the naked eye. The innermost planet, Mercury, keeps so close to the Sun that it is perpetually engulfed in twilight. So there are only four planets that are prominent in the night sky: Venus, Mars, Jupiter and Saturn. The positions of these four planets each month for a five-year period are given in the monthly notes in this book. The planets appear close to the plane of the ecliptic, the Sun's yearly path around the sky, shown as a dotted line on the maps in this book.

The brightest planet is Venus, for two reasons: it comes closer to the Earth than any other planet, and it is entirely shrouded by highly reflective clouds. Venus is popularly termed the morning or evening 'star', seen shining brilliantly in twilight before the Sun rises or after it has set. As Venus orbits the Sun it goes through phases like those of the Moon, noticeable through small telescopes and binoculars.

The second brightest planet as seen from Earth is Jupiter, the largest planet of the solar system. Binoculars reveal its rounded disk and its four brightest moons. Mars, when closest to us, appears as a bright red star, but it is too small to show much detail through small telescopes. Saturn at its closest appears like a bright star, and binoculars just show the outline of the rings that girdle its equator.

It is often said that planets do not twinkle, but this is not entirely correct. Some twinkling of planets can be seen on particularly unsteady nights, but since planets are not point sources they certainly twinkle far less than stars.

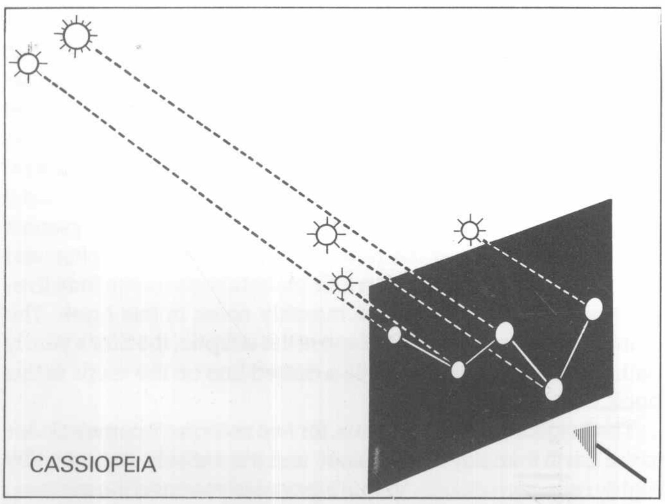
What is a constellation?

About 4500 years ago, people of the eastern Mediterranean began to divide the sky into easily recognizable patterns, to which they gave the names of their gods, heroes and fabled animals. Such star patterns are known as constellations. They were useful to seamen for navigation and to farmers who wanted to tell the time of night or the season of the year. By the time of the Greek astronomer Ptolemy in AD 150, 48 constellations were recognized.

Since then, various astronomers have introduced new figures to fill the gaps between the existing ancient constellations. Many of the new groups lie in the far southern part of the sky that was invisible to the Greeks. Some of the newly invented constellations have since been abandoned, others have been amalgamated, and still others have had their names or boundaries changed. This haphazard process has left a total of 88 constellations, of all shapes and sizes, covering the entire sky like pieces of a jigsaw.

They are all given Latin names. The constellation names and boundaries are laid down by the International Astronomical Union, astronomy's governing body.

The stars in a constellation are usually unrelated, lying at widely differing distances from us and from each other (see diagram), so the patterns they form in the sky are entirely accidental. One fact which dismays beginners is that few constellations bear any resemblance to the objects they are supposed to represent. Constellations are best thought of not as pictures in the sky but as a convenient way of locating celestial objects.



Stars in a constellation lie at different distances from us, as in the case of Cassiopeia.

How did the stars get their names?

Most bright stars, and several not-so-bright ones, have strange-sounding names. Other stars are known merely by letters and numbers. These designations arose in various ways, as follows.

A number of star names date back to Greek and Roman times. For example, the name of the brightest star in the sky, Sirius, comes from the Greek word for sparkling or scorching, in reference to its brilliance. The name of another bright star, Antares, is Greek for 'rival of Mars', on account of its strong red colour, similar to that of the planet Mars. The brightest star in the constellation Virgo is named Spica, from the Latin meaning 'ear of corn', which the harvest goddess Virgo is pictured holding.

But most of our star names are Arabic in origin, and were introduced into Europe in the Middle Ages through the Arab conquest of Spain. For example, Aldebaran is Arabic for 'the follower', from the fact that it follows the star cluster known as the Pleiades across the sky. Fomalhaut comes from the Arabic meaning 'mouth of the fish', from its position in the constellation Piscis Austrinus, the Southern Fish. Betelgeuse is a corruption of the Arabic *yad al-jawza*, meaning 'the hand of Orion'. Its name is often mistranslated as 'armpit of the central one'.

In all, several hundred stars have proper names, but only a few dozen names are commonly used by astronomers. Usually, astronomers refer to stars by their Greek letters, assigned in 1603 by the German astronomer Johann Bayer; hence these designations are known as Bayer letters. On this system, Betelgeuse is Alpha (α) Orionis, meaning the star Alpha in the constellation of Orion. Another system of labelling stars is by their numbers in a star catalogue compiled by the English astronomer John Flamsteed. These are known as Flamsteed numbers, and they are applied to fainter stars that do not have Bayer letters, such as 61 Cygni. (Note that the genitive case of a constellation's name is always used with Bayer letters and Flamsteed numbers). Stars too faint to be included in these systems, or stars with particular characteristics, are referred to by the numbers assigned to them in a variety of specialized catalogues.

How far are the stars?

So remote are the stars that their distances are measured not in kilometres or miles but in the time that light takes to travel from them to us. Light has the fastest speed in the Universe, 300,000 km/sec (186,000 mile/sec). It takes just over 1 second to cross the gap from the Moon to the Earth, 8.3 minutes to reach us from the Sun, and 4.3 years to reach the Earth from the nearest star, Alpha Centauri. Hence Alpha Centauri is said to be 4.3 light years away.

A light year is equivalent to 9.5 million million km (5.9 million million miles), so that in everyday units Alpha Centauri is about 40 million million km (25 million million miles) away. Even our fastest space probes would take about 80,000 years to get to Alpha Centauri, so there is no hope of exploring the stars just yet.

Most of the stars visible to the naked eye lie from dozens to hundreds of light years away. It is startling to think that the light entering our eyes at night left those stars so long ago. The most distant stars that can be seen by the naked eye are over 1000 light years away, for example Deneb in the constellation Cygnus and several of the stars in Orion. Only the most luminous stars, those that blaze more brightly than 50,000 Suns, are visible to the naked eye over such vast distances. At the other end of the scale, the feeblest stars emit less than a thousandth the light of the Sun, and even the closest of them cannot be seen without a telescope.

How bright are the stars?

The stars visible to the naked eye range more than a thousandfold in brightness, from the most brilliant one, Sirius, to those that can only just be glimpsed on the darkest of nights. Astronomers term a star's brightness its magnitude. The magnitude system is one of the odder conventions of astronomy.

Naked-eye stars are ranked in six magnitude classes, from first magnitude (the brightest) to sixth magnitude (the faintest). A difference of five magnitudes is defined as equalling a brightness difference of exactly 100 times. Hence a step of one magnitude corresponds to a difference of about 2.5 times in brightness. A difference of two magnitudes corresponds to a brightness difference of $2.5 \times 2.5 = 6.3$ times. Three magnitudes equals a brightness difference of $2.5 \times 2.5 \times 2.5 = 16$ times, and so on.

A star 2.5 times brighter than magnitude 1.0 is said to be of magnitude 0. Objects brighter still are assigned negative magnitudes. Sirius, the brightest star in the sky, has a magnitude of -1.46.

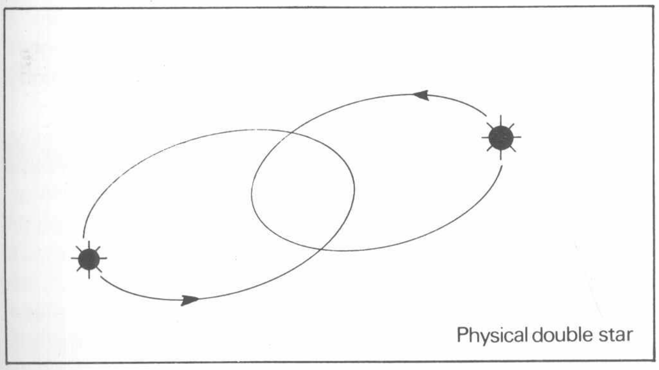
The magnitude system can be extended indefinitely to take account of the brightest and the faintest objects. For instance, the Sun has a magnitude of -27. Objects fainter than sixth magnitude are classified in succession as seventh magnitude, eighth magnitude, and so on. The faintest objects that can be detected by telescopes on Earth are about magnitude 25.

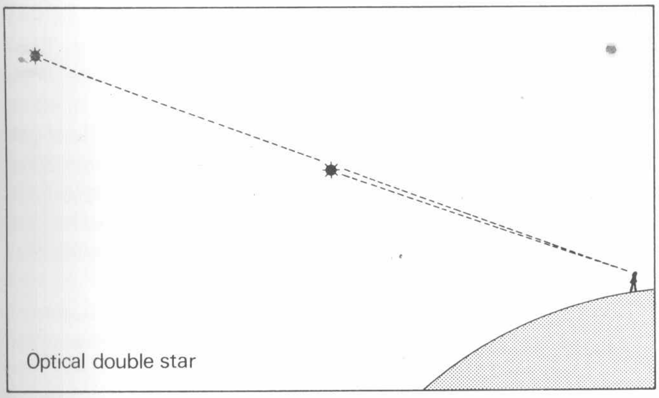
What are double stars?

Most stars are not single, as they appear to the naked eye, but have one or more companion stars, a number of which can be seen through small telescopes, and some with binoculars. The visibility of the companion star depends on its brightness and its distance from the primary star – the closer the stars are together, the larger the aperture of telescope that is needed to separate them.

Usually, the members of a star family all lie at the same distance from us and orbit each other like the planets around the Sun. A pair of stars genuinely related in this way is known as a binary. But in a smaller number of cases one star simply lies in the background of another, at a considerably different distance from us. Such a chance alignment of two unrelated stars is termed an optical double.

One of the attractions of double and multiple stars is the various combinations of star colours that are possible. For example, one of the most beautiful double stars is Albireo in the constellation Cygnus, which consists of amber and green stars, looking like a celestial traffic light. Other impressive double and multiple stars are mentioned in the constellation notes.





Most double stars are related (a physical double), but some lie by chance in the same line of sight (an optical double).

What are variable stars?

Not all stars are constant in brightness. Certain stars change noticeably in brightness from night to night, and some even from hour to hour. The brightest of the varying stars is Betelgeuse, which ranges a full magnitude (i.e. 2.5 times) between maximum and minimum intensity, taking many months or even years to go from one maximum to the next. The variations in the light output of Betelgeuse are caused by changes in the actual size of the star. Although the variations of Betelgeuse have no set period, a number of stars pulsate regularly, like a beating heart, every few days or weeks. These are known as *Cepheid variables*, and they follow the rule that the longer the cycle of variation, the more luminous is the star.

Some stars which appear to vary in brightness are actually close pairs in which one star periodically eclipses the other, temporarily blocking off its light from us. The prototype of these so-called *eclipsing binaries* is Algol, in the constellation Perseus, which fades to one-third its usual brightness every 2 days 20 hours 49 minutes. This and other interesting variable stars are mentioned in the constellation notes.

The most spectacular of the varying stars are the *novae*, faint stars which can flare to thousands of times their usual brightness for a few days before sinking back into obscurity. Novae got their name, which is Latin for 'new', because in the past they were really thought to be new stars appearing in the sky. Now we know that a nova is actually an old, dim star that has flared up because gas has fallen onto it from a neighbour. Nova outbursts are unpredictable, and are often first spotted by amateur astronomers.

What is a shooting star?

During your sky watching, you will from time to time see a bright streak of light dash across the sky like a cosmic laser beam, lasting no more than a second or so. This is a *meteor*, popularly termed a shooting star. Do not misidentify shooting stars with satellites or high-flying aeroplanes, which look like moving stars but drift at a more leisurely pace.

Despite their name, shooting stars are nothing to do with stars at all. They are particles of dust shed by comets and are usually no bigger than a grain of sand. They plunge into the Earth's atmosphere at speeds from 10 to 75 km/sec (6 to 46 mile/sec). We see the glowing streak of hot gas as the dust particle burns up by friction with the atmosphere about 100 km (60 miles) above the Earth. The brightest meteors outshine the stars, and some break up into glowing fragments. Occasionally, much larger chunks of rock and metal penetrate the atmosphere and land on Earth. These are called meteorites.

On any clear night, several meteors are visible to the naked eye each hour, burning up at random. These are known as *sporadic* meteors. But at certain times of the year the Earth ploughs through dust storms moving along the orbits of comets. We then see a meteor shower, when as many as 100 meteors may be visible each hour.

Owing to an effect of perspective, all the members of a meteor shower appear to diverge from a small area of sky known as the *radiant*. The meteor shower is named after the constellation in which its radiant lies: the Perseids appear to radiate from the constellation of Perseus, the Geminids from Gemini and so on. Meteor showers recur on the same dates each year, although the intensity of a shower can vary from year to year. As the Earth penetrates the swarm of dust, the number of meteors visible each hour builds up over a few days to its maximum, and then falls away again. Amateur astronomers monitor the progress of a shower by counting the number of meteors visible, and estimating their brightnesses.

When watching for meteors from a shower, do not look directly at the radiant, but look about 45° to one side of it. A list of the year's main meteor showers is given in the table overleaf. Note that the maximum number of meteors shown in column three will be seen only in dark conditions, when the radiant is high in the sky. If the radiant is low, or if the sky is bright (for instance from moonlight), the number of meteors visible will be very much smaller.

METEOR SHOWERS		
Name of shower	Date of maximum	Number of meteors visible per hour at maximum (approx.)
Quadrantids	January 3–4	100
Lyrids	April 21–22	10
Eta Aquarids	May 5–6	35
Delta Aquarids	July 28–29	20
Perseids	August 12–13	75
Orionids	October 22	25
Taurids	November 4	10
Leonids	November 17–18	10
Geminids	December 13–14	75

What is a comet?

People often confuse comets with shooting stars, but they are quite different things. Whereas a shooting star appears as a brief streak of light, a comet looks like a hazy smudge hanging in the sky. A comet's movement against the star background is noticeable only over a period of hours, or from night to night. Comets are snowballs of frozen gas and dust that move on highly elongated orbits around the Sun, taking from a few years to many thousands of years to complete one circuit.

Approximately two dozen comets are seen by astronomers each year. About half of these are previously known comets returning to the inner part of the solar system, while the others are new discoveries. Most comets are too faint to be seen without a large telescope. Only rarely, perhaps every ten years or so, does one become bright enough to be prominent to the naked eye.

A bright comet is awesomely beautiful. From its glowing head stretches a transparent tail of gas and dust, extending for millions of kilometres. A comet's tail always points away from the Sun. The dust released by the comet disperses into space, some of it eventually being swept up by the Earth to appear as meteors.

What is the Milky Way?

On clear, dark nights, a hazy band of starlight arches across the heavens. The Greeks called it the Milky Way. We know that the Milky Way consists of innumerable stars comprising an enormous wheel-shaped structure, the Galaxy, of which our Sun is a member. The stars that are scattered randomly over the night sky, forming the constellations, are among the nearest to us in the Galaxy. The more distant stars are concentrated into the crowded band of the Milky Way. The Milky Way, therefore, is the rest of our Galaxy as seen from our position within it.

The Galaxy's centre lies in the direction of the constellation Sagittarius, where the Milky Way star fields are particularly dense. Our Sun lies approximately two-thirds of the way from the hub to the rim of the Galaxy, which is about 100,000 light years in diameter. Beyond the edge of the Galaxy is empty space, dotted with other galaxies.

On the monthly star maps, the Milky Way is indicated in light blue. Sparkling star fields spring into view if you sweep along this region with binoculars or small telescopes.

What is a star cluster?

In places, stars congregate in clusters, some of which are visible to the naked eye, most notably the group called the Pleiades in the constellation Taurus. There are two sorts of star cluster, distinguished by the types of stars in them and their location in the Galaxy. *Open clusters* are loose groupings of young stars dotted along the spiral arms of our Galaxy. Some open clusters, such as the Pleiades, are still surrounded by traces of the gas clouds from which they were born. Open clusters can contain from a handful of stars up to a few thousand stars.

Altogether different in nature are the ball-shaped *globular clusters*, mostly found well away from the plane of the Milky Way. They are swarms of up to 300,000 stars, much more tightly bunched together than in open clusters. The stars in globular clusters are very old – indeed, they include some of the oldest stars known. Since globular clusters are much further away from us than open clusters, they appear fainter. The best globular cluster for northern observers is M13 in the constellation Hercules.

What is a nebula?

Between the stars are vast clouds of gas and dust known as *nebulae*, the Latin for mist, a word that accurately describes their foggy appearance. They are best seen in clear country skies, away from smoke and streetlights.

Some nebulae shine brightly, whereas others are dark. The most famous bright nebula is in Orion, visible to the naked eye as a softly glowing patch. The Orion Nebula is a gas cloud from which stars are forming, and the new-born stars at its centre light up the surrounding gas (see page 18). Other nebulae remain dark because no stars have yet formed inside them. Dark nebulae become visible when they are silhouetted against dense star fields or bright nebulae. The Milky Way star fields in Cygnus are bisected by a major dark nebula, the Cygnus Rift.

Certain nebulae are formed by the deaths of stars, including the so-called *planetary nebulae* which, despite their name, have nothing to do with planets. The name arose because, when seen through small telescopes, they often look like the disks of planets. Actually, planetary nebulae are glowing shells of gas sloughed off by stars like the Sun at the ends of their lives. Stars that are much more massive than the Sun die in violent explosions, splashing fountains of luminous gas into space. The most famous remnant of an exploded star is the Crab Nebula in the constellation Taurus (see page 63).

What is a galaxy?

Some objects that at first sight resemble nebulae are actually distant systems of stars beyond our Milky Way – other galaxies, many millions of light years apart, dotted like islands throughout the Universe. The smallest galaxies consist of approximately a million stars, while the largest galaxies contain a million million stars or more. We live in a fair-sized galaxy of about 100,000 million stars.

Galaxies come in two main types: spiral and elliptical. Spiral galaxies, of which our Galaxy is one, have arms consisting of stars and gas winding outwards from their star-packed centres. A sub-species of spiral galaxies, called barred spirals, have a bar of stars across their centre; the spiral arms emerge from the ends of the bar. Elliptical galaxies have no spiral arms. They range in shape from almost spherical to flattened lens shapes.

NAMING STAR CLUSTERS, NEBULAE AND GALAXIES

Star clusters, nebulae and galaxies are often referred to by numbers with the prefix M or NGC. The M refers to Charles Messier, an eighteenth-century French comet hunter who compiled a list of over 100 fuzzy-looking objects that might be mistaken for comets. Astronomers still use Messier's designations, and enthusiasts avidly track down the objects on his list. In 1888 a far more comprehensive listing of star clusters and nebulous objects was published, called the *New General Catalogue of Nebulae and Clusters of Stars*, or NGC for short. This was followed by two supplements known as the *Index Catalogues* (IC), bringing the total number of objects catalogued to 13,000, most of them only within reach of large telescopes. In this book we use the Messier numbers where they exist, or NGC and IC numbers otherwise.

Time-exposure photographs with large telescopes are needed to bring out the full beauty of galaxies. Through binoculars and small telescopes, most galaxies appear only as hazy patches of light. Like nebulae, galaxies are best seen in clear, dark skies.

The nearest major galaxy to us is visible to the naked eye in the constellation of Andromeda. It appears as a faint smudgy patch, similar in apparent width to the full Moon. The Andromeda Galaxy is a spiral galaxy, 2 million light years from us (see page 53).

How to look at the stars

To begin stargazing you need nothing more than your own eyes, supplemented by a modest pair of binoculars. The monthly star charts in this book are designed to be used for stargazing with the naked eye. With these charts, you will be able to identify the stars and constellations visible on any night of the year.

Specific constellations are featured in more detail in the monthly star notes, and to study the objects described in them requires some form of optical aid. Optical instruments collect more light than the naked eye does, thus showing fainter objects as well as making objects appear bigger by magnifying them. In astronomy, the ability of an instrument to collect light is often more important than the amount by which it magnifies. This is particularly so in the case of binoculars, which are an indispensable starting instrument for any would-be stargazer.

Binoculars usually have relatively low magnifications of between six and ten times, so they will not show detail on the planets, but their light-grasp will bring into view many stars and nebulae that are beyond reach of the naked eye. Binoculars have a much wider field of view than telescopes, and so are better suited for studying extended objects such as scattered star clusters. Even if you subsequently obtain a telescope, binoculars will remain of use.

Binoculars bear markings such as 6 × 30, 8 × 40 or 10 × 50. The first figure is the magnification, and the second figure is the aperture of the front lenses in millimetres: the larger the aperture, the greater the light-grasp and hence the fainter the objects that you can see. Binoculars with high magnifications of 12 times or more are occasionally encountered, but these need to be mounted on a tripod to hold them steady.

Telescopes are rather like telephoto lenses, but whereas a telephoto lens on a camera is described by its focal length a telescope is described by its aperture. Remember that a telescope with an aperture of, say, 50 mm has the same light-grasp as a pair of 50 mm binoculars, but it can cost several times more. The main advantage of a telescope over binoculars is that it has higher magnification.

The smallest telescopes – those with apertures up to 75 mm (3 inches) – are of the refracting type, like a spyglass, which you look straight through. Larger telescopes, starting with apertures of 100 mm (4 inches), are usually reflectors, in which mirrors collect the light and bounce it into an eyepiece. Reflectors are cheaper to make in large sizes than refractors, and they have shorter tubes, which is more convenient.

A problem that becomes apparent through a telescope is the unsteadiness of the atmosphere. Turbulent air currents make the image of a star or planet seem to boil and jump around, which limits the amount of detail that can be discerned, particularly at higher magnifications. The steadiness of the atmosphere is known as the *seeing*, and it changes markedly from night to night.

Telescopes have interchangeable eyepieces which give a range of magnifications. High magnifications are useful when studying fine detail on the planets or separating the close components of a double star. But no matter how much magnification you use on a small telescope, it will not show as much detail as a larger telescope. In fact, too high a power on a telescope will make the image so faint that you will end up seeing less than if you had used a lower power. A good rule of thumb is to keep to a maximum magnification of 20 times per 10 mm of aperture (50 times per inch). Do not be tempted by small telescopes that offer magnifying powers of many hundreds of times. In practice, such high magnifications will be unusable.

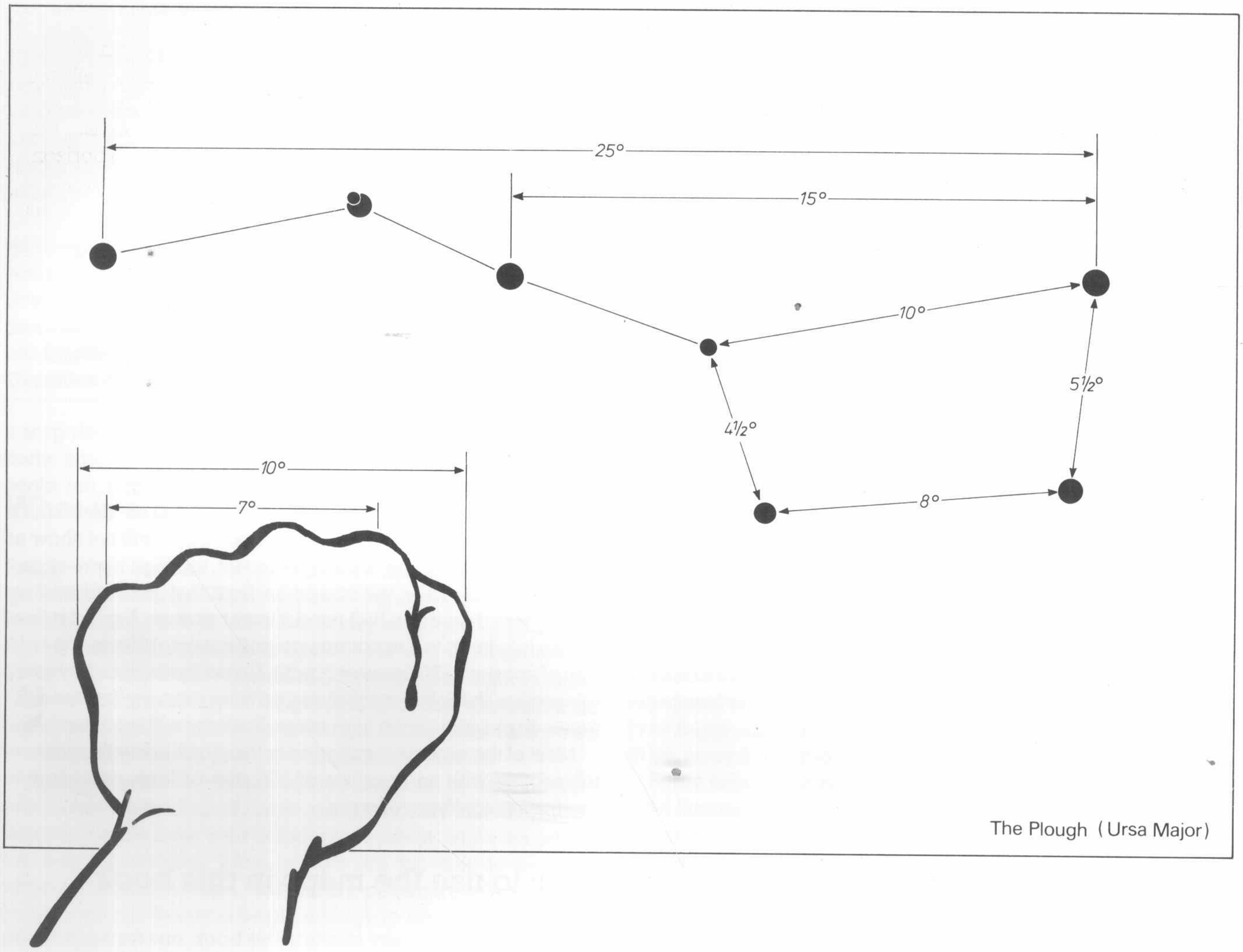
Most of the objects mentioned in this book are within view of telescopes with an aperture of 100 mm or less, using low to medium magnifying powers.

How to use the maps in this book

There are twelve all-sky charts in this book, one for each month of the year, usable every year. They show the sky as it appears between latitudes 30° north and 60° north at fixed times of night that are convenient for observation. To understand the maps, imagine the night sky as a dome overhead. The maps are a flattened representation of that dome. The map projections have been carefully chosen to minimize distortion of the constellation shapes on the printed page.

To use the maps, turn them so that the direction marked at the bottom of the map – north, south, east or west – matches the direction you are facing. The map then depicts the sky as it appears at 10 p.m. in mid-month. The sky will look the same at 11 p.m. at the start of the month and 9 p.m. at the end of the month. (NB: one hour must be added to these times when daylight saving is in operation, designated DST in the key.) When you look upwards you must think of the maps as being stuck to the dome of the sky, arching over you on all sides.

If you wish to observe at some other time than 10 p.m. in mid-month, you must make allowances for the changing appearance of the sky caused by the rotation of the Earth, which turns through 15° every hour. When your observing time differs by two hours from the time shown on a map, you will have to change maps. For example, if you are observing at midnight in mid-month rather than 10 p.m., move forward to the next map in the book – so to see how the sky will look at midnight in mid-January turn to the map for February, and so on. If you are observing two hours earlier than the time shown on a map (e.g. 8 p.m. in mid-January) then turn back to the map for the previous month (December, in this example). For every additional two hours difference in time, go forwards or backwards another map as necessary. It will become evident that, say, the sky at 6 a.m. in



The Plough (Ursa Major)

mid-January is the same as that shown on the map for 10 p.m. in mid-May.

Such map-switching will be necessary to find the times at which certain planets will be visible when they are located in constellations not above the horizon at 10 p.m. in a given month. For example, if a planet lies in Sagittarius during January, we have to move forward four maps (eight hours) to find that on which Sagittarius first appears above the horizon – the May map. Thus Sagittarius, and the planet, do not rise until nearly dawn in January.

Four horizons are shown on the maps, for observers at latitude 30° north, 40° north, 50° north and 60° north. It should not be difficult to work out where the horizon falls on the maps for your specific latitude. You will be able to use the maps from anywhere between latitudes 30° north and 60° north, and up to 10° outside these limits there will be hardly any discrepancy between what the maps show and the way the sky appears. Note how your latitude affects the stars that are visible.

The monthly maps show the brightest stars down to magnitude 5.0, realistically depicting the sky as seen by the naked eye on an averagely clear night. The maps of individual constellations show stars down to magnitude 6.5, plus fainter selected stars and numerous objects of interest for users of binoculars and small telescopes.

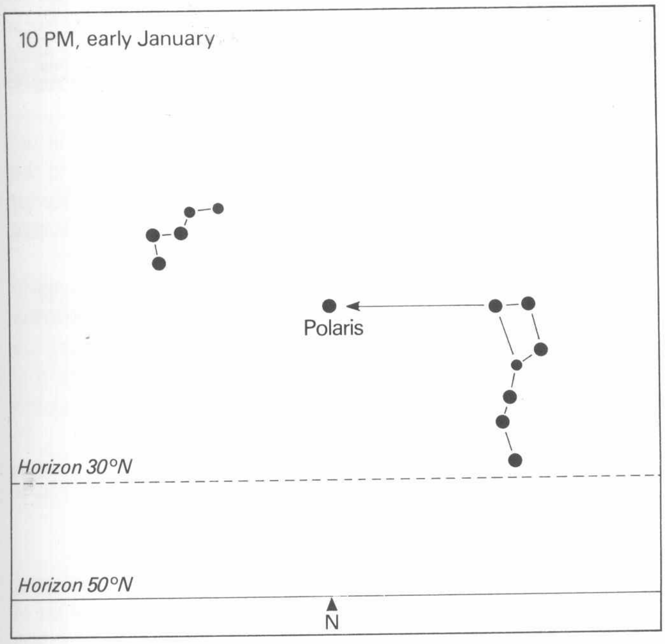
Scale in the sky

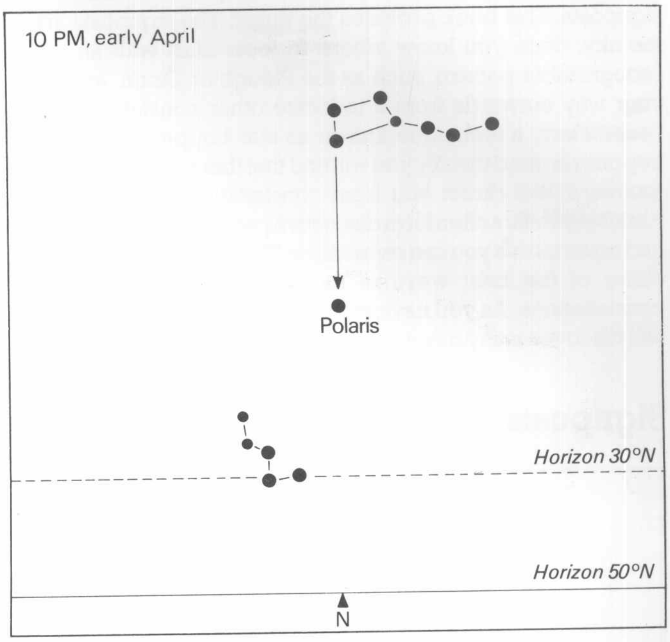
One difficulty when matching up the maps in a book with the appearance of the real sky is the matter of scale. Most people overestimate the size of objects in the sky. For example, it is a remarkable fact that the full Moon, which is half a degree across, can be covered by the width of a pencil held at arm's length. (Try it!) An outstretched palm will cover the main stars of Orion, and you can cover most of the stars in the Plough with your hand.

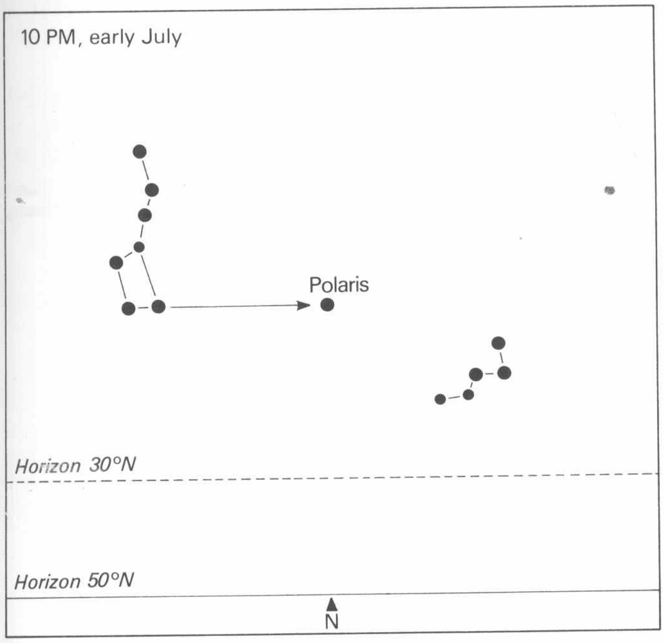
How can we judge whether a particular constellation covers a large or a small area of sky? The width of a fist held at arm's length makes an ideal distance indicator, about 7° wide. As a guide to scale, each of the detailed constellation maps in this book carries an outline of a fist for comparison. If your hand is unusually big or small the comparison will not be exact, but it will still be a useful guide to the size of constellation you are looking for.

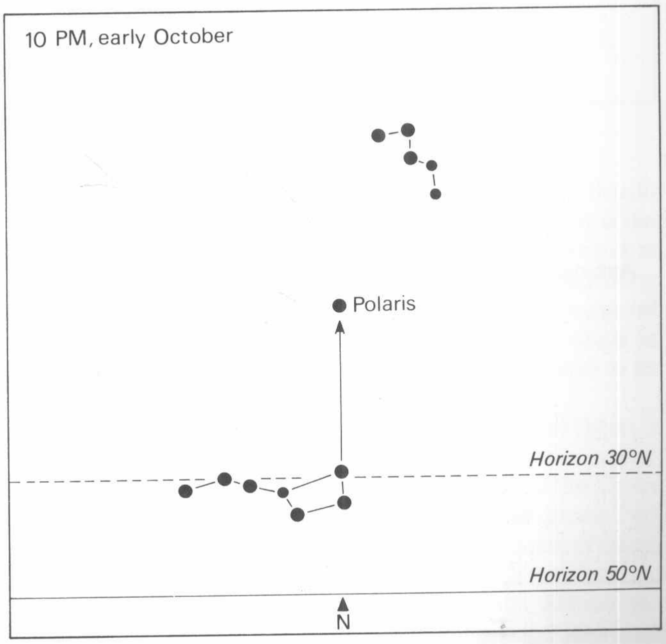
HOW THE SKY CHANGES WITH THE SEASONS

The sky is like a clock and a calendar. It changes in appearance with the time of night and with the seasons of the year. For example, look at these diagrams of the area around the north pole of the sky. At 10 p.m. at the start of the year, the familiar saucepan-shape of seven stars known variously as the Plough or Big Dipper is standing on its handle to the right of Polaris, the north pole star. At the same time of night three months later, the Plough is almost directly overhead, while the W-shaped constellation of Cassiopeia sits low on the northern horizon. By July, the Plough appears to the left of Polaris. At 10 p.m. in October the Plough is scraping the northern horizon, while Cassiopeia rides high. In another three months the stars are back to where they started and the yearly cycle begins anew.









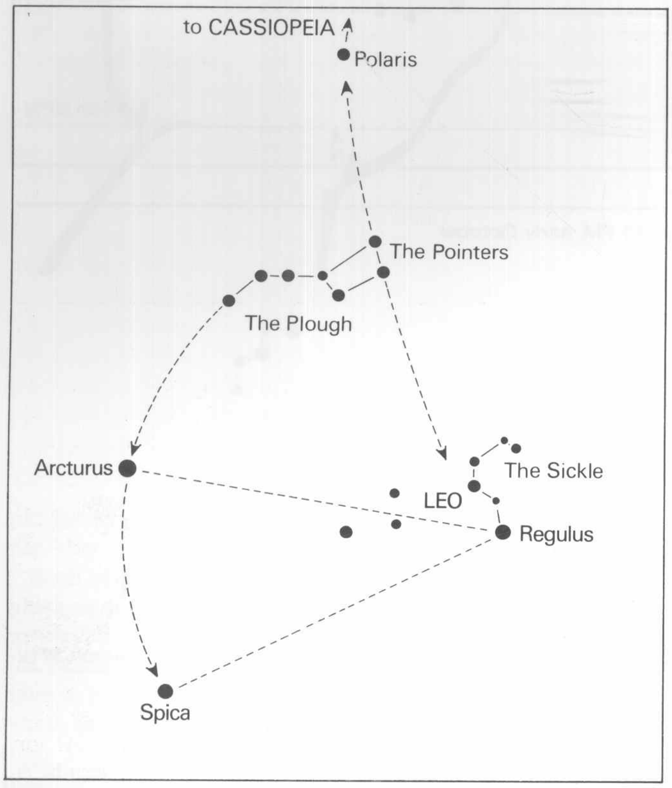
Greek alphabet

α	alpha	η	eta	ν	nu	τ	tau
β	beta	ϑ or θ	theta	ξ	xi	υ	upsilon
γ	gamma	ι	iota	o	omicron	φ or ϕ	phi
δ	delta	$\varkappa$ or κ	kappa	π	pi	χ	chi
ε or ϵ	epsilon	λ	lambda	ρ	rho	ψ	psi
ζ	zeta	μ	mu	σ	sigma		

FINDING YOUR WAY

To find your way in unfamiliar territory, you need a map and signposts. This book provides the maps. The signposts are in the sky, once you know where to look. Start with an easily recognizable pattern, such as the Plough or Orion, and work your way outwards from it to locate other constellations and bright stars, a technique known as star-hopping. While star-hopping around the sky you will find that there are many natural 'pointers' that direct you from constellation to constellation. Also, bright stars often form distinctive patterns of lines, triangles and squares that you can remember. These pages demonstrate some of the best ways of locating prominent stars and constellations. As you navigate your way among the stars you will discover many more signposts of your own.

Signposts of spring



Start with the familiar saucepan-shape of the Plough or Big Dipper, which rides high in the sky on spring evenings. The seven stars of the saucepan are actually the most prominent members of the constellation Ursa Major, the Great Bear. From the diagram you can see that two stars of the saucepan's bowl – the ones that lie furthest from the handle – point towards the north pole star, Polaris. These two stars in the Plough are popularly known as The Pointers. If you extend the distance between them by about five times you will reach the pole star. Opposite Polaris from the Plough lie five stars that form a distinctive W-shape, which is the constellation of Cassiopeia.

Polaris is a star of moderate brightness lying in a somewhat blank region. It is not exactly at the north pole of the sky, but is situated about one degree from it. During the night the stars circle around the north celestial pole (and hence around Polaris) as the Earth spins on its axis.

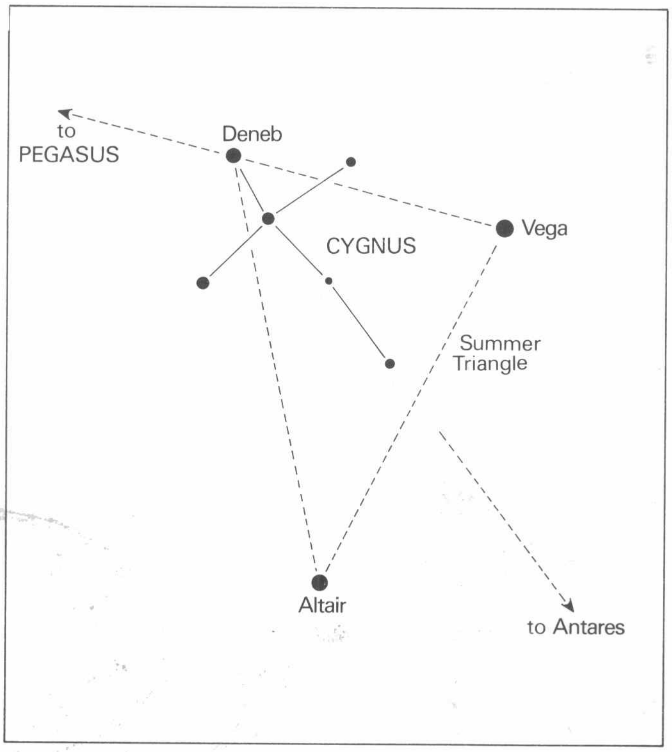
Go back to the Plough. If you extend the Pointers in the opposite direction, away from Polaris, you will come to the constellation of Leo, the Lion. This constellation is notable for the sickle-shape of stars, like a reversed question mark, that make up the lion's head.

Now look at the handle of the Plough. Follow the curve made by the stars of the handle until you come to Arcturus, one of the brightest stars in the sky. Continue the curve and you reach the sparkling star Spica, in the constellation of Virgo. Note that Arcturus and Spica form a prominent triangle with Regulus, the brightest star in Leo.

Signposts of summer

High in the sky on summer evenings lies an isosceles-shaped trio of bright stars known as the Summer Triangle. In order of decreasing brightness they are Vega, Altair and Deneb. Vega is the fifth-brightest star in the sky, and is the first star to appear as the sky darkens in July and August, shining overhead like a blue-white diamond.

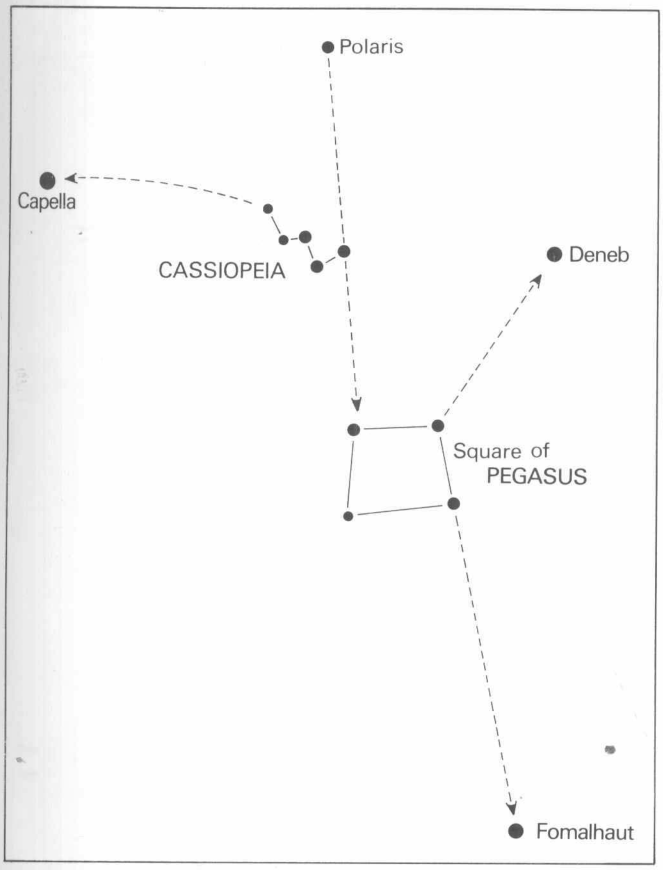
Deneb is the brightest star in Cygnus, a constellation that represents a swan but which is better visualized as a cross, as shown on the diagram here. Deneb marks the head of the cross.



The foot of the cross bisects a line between Vega and Altair, and points towards the bright star Antares, which appears low on the horizon from mid-northern latitudes. Antares lies due south as the sky darkens in July. It has a prominent red colour, and represents the heart of the Scorpion, Scorpius.

A line from Vega through Deneb directs you towards the Square of Pegasus, a quadrangle of four stars that is the centrepiece of the autumn sky. Apart from the Summer Triangle, the summer sky is remarkably bereft of prominent star patterns. Incidentally, despite its name the Summer Triangle remains visible well into the autumn.

Signposts of autumn

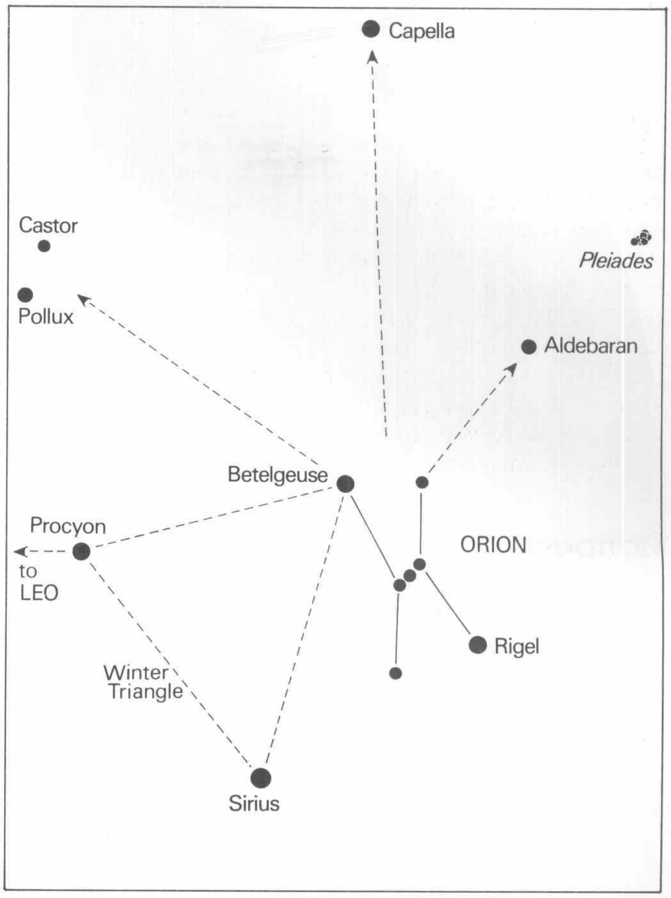


As the Summer Triangle sets in the west on autumn evenings, the Square of Pegasus takes centre stage. The Square lies high in the south at 10 p.m. in mid-October, 8 p.m. in mid-November, and 6 p.m. in mid-December. The four stars that mark the corners of the Square are of only moderate brightness. They enclose a large area of sky that is almost entirely devoid of naked-eye stars.

The Square of Pegasus is like a keystone in the autumn sky, from which many surrounding stars and constellations can be identified. To the top right of the Square lie Deneb and the rest of the Summer Triangle. Between the Square and the pole star lies the W-shaped constellation of Cassiopeia. As the diagram shows, a line extended upwards from the left-hand side of the Square passes through the end of the W shape and on to Polaris. Alternatively, you can use this line in reverse, running it from Polaris through Cassiopeia, to find the Great Square. A line extended downwards from the right-hand side of the Square directs you to Fomalhaut, a bright star in the southern constellation of Piscis Austrinus, but often difficult to find from mid-northern latitudes because it is so close to the horizon.

Now look at Cassiopeia, riding high above you. A line drawn across the top of the W points to Capella, one of the prominent stars of the winter sky.

Signposts of winter

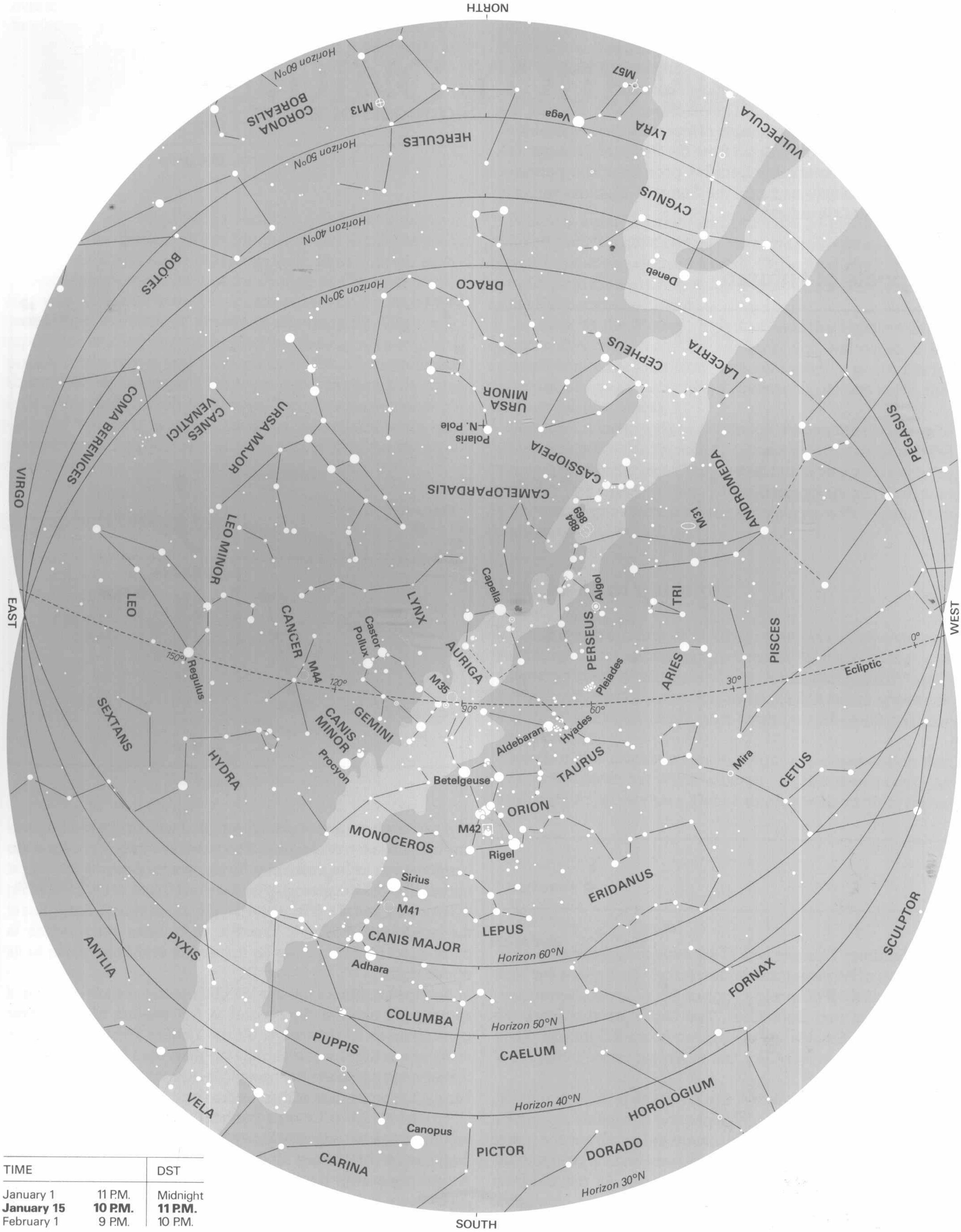


The sky in winter is more richly stocked with bright stars than in any other season of the year. The jewel in winter's crown is the brightest star in the entire sky, Sirius, which glitters due south at midnight at the beginning of January, at 10 p.m. at the beginning of February and at 8 p.m. at the beginning of March. Sirius lies at the apex of the Winter Triangle of brilliant stars, which is completed by Procyon to its upper left and Betelgeuse to its upper right.

Betelgeuse marks the top left of the constellation of Orion, a rectangular-shaped figure that is the easiest of the winter constellations to recognize. At the bottom right of the Orion rectangle is Rigel, a star slightly brighter than Betelgeuse. Two fainter stars complete the rectangle. Across the centre of Orion runs a distinctive line of three stars comprising Orion's belt.

To the top right of Orion is another prominent star, Aldebaran, which represents the glinting eye of Taurus, the Bull. Aldebaran is of similar brightness to Betelgeuse, and both stars have a noticeably orange tinge. Continue the line from Orion through Aldebaran and you will come to a hazy-looking knot of stars called the Pleiades, a star cluster that shows up well in binoculars.

Above Orion, almost directly between it and the north celestial pole, lies the bright star Capella. To the top left of Orion, above the Winter Triangle, lies a famous pair of stars called Castor and Pollux, the celestial twins in the constellation Gemini. Off to the left of Castor, Pollux and Procyon lies Leo, the Lion, which introduces us once again to the skies of spring.



TIME		DST
January 1	11 P.M.	Midnight
January 15	**10 P.M.**	**11 P.M.**
February 1	9 P.M.	10 P.M.

Magnitudes	−1	0	0	1	1	2	2	3	3	4	4	5
	>-0.5	-0.5 – 0.0	0.1 – 0.5	0.6 – 1.0	1.1 – 1.5	1.6 – 2.0	2.1 – 2.5	2.6 – 3.0	3.1 – 3.5	3.6 – 4.0	4.1 – 4.5	4.6 – 5.0

Double or multiple stars
Variable stars
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies

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